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HEMORRHAGIC SEPTICEMIA
AND
ITS CONTROL IN PENNSYLVANIA

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Harrisburg, July 29, 1918.

Hon. Chas. E. Patton,
Secretary of Agriculture, Harrisburg, Pa.

Dear Mr. Secretary:—

I am herewith transmitting an article on Hemorrhagic Septicemia and its control in Pennsylvania by Drs. J. B. Hardenbergh and Fred Boerner, Jr. of the Division of Laboratories of the State Live-stock Sanitary Board.

This disease has also been designated as "Shipping Fever" and "Stock Yard Pneumonia." It has been reported as existing in some foreign countries and many of the States of this Country. During recent years it has become of considerable economic importance due to numerous outbreaks and losses among shipped cattle which pass through our public stock yards. At this time, when the conservation of meat is of such vital importance to ourselves and our allies, every effort should be made to reduce those losses to a minimum.

This paper gives in brief the history and occurrence of Hemorrhagic Septicemia in this State, the symptoms and anatomical changes, together with the results obtained by vaccination. I believe that if placed in the hands of veterinarians and stockmen it will be of considerable assistance in their efforts to prevent and control this disease. I am, therefore, recommending that it be published in the form of a bulletin for distribution.

Respectfully yours,

T. E. MUNCE,
Acting State Veterinarian.



HEMORRHAGIC SEPTICEMIA AND ITS CONTROL IN PENNSYLVANIA

J. B. Hardenbergh and Fred Boerner, Jr.

In presenting data gathered during our three years experimental work with vaccine in the control of hemunorrhagic septicemia, we intend to dwell but briefly upon the occurrence, etiology, anatomical changes, symptoms, etc., of the disease. For these details the reader is referred to some of the recent work in veterinary medicine regarding pathology and therapeutics or pathology and diagnosis. It is our purpose to show from statistics gathered in vaccinating over 2,000 cattle on various farms throughout the State, why we feel that this method of control is valuable.

In his annual report for 1895, Pearson mentioned sudden deaths of cattle due to some unknown cause and concluded that, while many were due to known diseases not recognized, others were no doubt due to diseases of which but little was known, or that certain poisons had operated to destroy the animals.

In 1896 his report cited the occurrence of an outbreak in Lancaster County in November. Twelve animals were found ill, eleven unable to stand; all had a low fever slightly accelerated pulse. Their appetites were gone, and there were indications of abdominal pain, while weakness seemed to be more noticeable in the hind quarters than in the front. Some animals show considerable excitement, and all but two were constipated. Necropsy on two that died revealed only slight changes in most of the parenchymatous organs, but there were some changes of the digestive tract, also a yellowish serum around the kidneys, and congestion of the lungs. There was a history of their having been kept in a corn stalk field for five days prior to the time when it was noticed that they staggered in walking, rapidly lost strength, became unable to stand, and exhibited the other symptoms mentioned.

In 1897 reference is made to an outbreak in Huntingdon County, following the purchase of seven yearlings in Centre County, which shortly after reaching their destination developed a severe cough, lost condition, and became emaciated, four of the animals dying. Subsequently some other cattle on this farm developed similar symptoms, leading to the belief that the affection was contagious. The

owner, suspecting tuberculosis, had the animals tuberculin tested with entirely negative results. A post-mortem examination on one of the heifers showed that the anterior lobes of the lungs were solidified, dark red in color and upon cross section revealed numerous small cavities, containing a yellowish cheesy pus. The bronchial tubes contained frothy mucus, and the lining membrane was thickened. The connective tissue septa between the lobules were infiltrated with serum and thickened; pleura, lymphatic glands, and other organs normal in appearance, although somewhat pale.

In 1898 the same writer made quite a lengthy reference to "Corn Stalk Disease" which had occasioned enormous losses in some of the principal corn growing states of the West, and referred to the outbreak mentioned in his 1896 report as being of the same nature. This disease was not supposed to be contagious, although its cause had not been fully ascertained. On account of the length of this report, we cannot quote from it fully. Outbreaks were reported from several farms in different counties, and the symptoms and autopsy findings seemed to warrant a diagnosis of "Corn Stalk Disease."

In this 1898 record a part of the report on investigation of an outbreak in Franklin County in December, reads as follows:—"All the animals that died recently had a history of having been fed from a few days to several weeks on corn fodder. *However, a number of animals had died on farms south of St. Thomas during the months of October and November of a disease having somewhat similar symptoms, were at pasture when they died, and had not received any corn fodder.*" This report also mentioned that while under certain conditions of moldiness and fermentation corn stalks and corn fodder become exceedingly poisonous to many cattle, it was noted that all cattle exposed in the same way did not become affected and that the symptoms varied.

In 1900 he reported a disease, prevailing in the spring and summer, among cattle in wild mountainous regions, that failed of identification during the year, but which destroyed several hundred cattle annually, and was so prevalent as to make large areas of land useless for pasturing purposes.

In 1902 investigations were conducted as to the etiology of the so called "Mountain Disease" as a result of which Pearson and Gilliland proved it to be identical with "Rinderseuche" of Germany, and with *hemorrhagic septicemia* that had been recognized among cattle in Minnesota and Wisconsin, stating that this discovery removed a cloud of doubt as to the cause of the loss of great numbers of cattle. In this same report, Pearson stated that "hemorrhagic septicemia or spotted fever" of cattle had also been known in Pennsylvania as "Carbon County Disease" or "Mountain Disease of Cattle," and that

it was believed to have occurred during that year in the counties of Cameron, Carbon, Center, Clearfield, Franklin, Forest, Huntingdon, Lackawanna, Lycoming, Perry, Potter, Somerset, Wayne, and Warren.

Following is a description of the symptoms and pathological changes noted by him: "Fever, loss of appetite, dullness, diminution of milk flow, groaning, discharge of bloody mucus from the nose, staring coat, red mucous membranes, swelling about the throat, which is hot, rather tense and painful, and is sometimes accompanied by harsh or difficult breathing. There is usually a little discharge of blood from the anus. Sometimes there is a little leakage of blood through the skin at various points as though the animal had been stung by large flies or pricked with needles. In other cases the disease seems to affect the intestinal tract chiefly and in such cases there is a diffuse hemorrhagic gastro-enteritis, causing much depression, accumulation of gas, evidence of pain in the abdominal cavity, and the feces are covered with blood, shreds of fibrin or mucus. The course of the disease is usually short, varying from twelve hours to a week, and terminates in death in nearly all cases.

On post-mortem examination it is observed that the tissues beneath the skin in the region of the throat are infiltrated with serum and that scattered through this infiltrated area there are many points of hemorrhage; sometimes the hemorrhage is extensive, causing the entire infiltrated area to be of a red color. This swelling about the throat usually involves the walls of the pharynx and larynx, and the root of the tongue is often swollen and infiltrated with yellow serum. Points of hemorrhage may be observed beneath the skin on any part of the body. Sometimes the lungs show evidence of hemorrhage into them, and there is an accumulation of blood in the chest cavity. If the intestines are involved there is hemorrhage into large or small areas of the wall, causing it to be of dark red color and considerably thickened. The appearance of the blood is not materially altered; it coagulates in the usual way. The most characteristic alterations are the points of hemorrhage indicating an escape of blood from the vessels into the subcutaneous connective tissues, into lining membranes of the abdominal and thoracic cavities, and into the swollen areas about the throat and at the root of the tongue. Young or old cattle may be afflicted by this disease.

In the foregoing references to the various named diseases, it is not claimed that those outbreaks of "Corn Stalk Disease" and catarrhal or broncho-pneumonia were what we now know as hemorrhagic septicemia, nor that they were due to an organism belonging to the hemorrhagic septicemia group. There are distinct pneumonias and certain distinct cases of forage poisoning, but from the fact that we do not have reports of these two diseases from counties where they pre-

viously existed; and as we are and have been for several years receiving reports of hemorrhagic septicemia outbreaks in these same counties, we are strongly inclined to the belief that many of the outbreaks previously reported under other names were in all probability due to an organism belonging to the hemorrhagic septicemia group. Investigations by Billings, Gangee, Mayo, Moore, and others, tend to confirm this belief.

Hemorrhagic Septicemia of cattle is usually an acute—less frequently a sub-acute—infectious disease, in the course of which the febrile symptoms are often accompanied by manifestations of an acute gastro-enteritis, inflammatory edema of the skin, or frequently a necrotic-pneumonia associated with edema of the inter-alveolar connective tissue. The causative agent is *B. bovissepticus*.

OCCURRENCE.

The disease occurs practically everywhere, either sporadically or enzootically, especially during the late summer and fall months. In Pennsylvania 90 per cent. of the outbreaks during the past three years have been reported in August, September and October. Since 1878, when described by Bollinger as occurring near Munich among deer and wild boars, it has been observed in cattle, sheep, hogs, and occasionally in horses and mules. Among the latter cases may be mentioned an outbreak in Lancaster County, Penna., August 1916, in young mules, resulting in five deaths, the subsequent necropsy and bacteriological findings in the two cases confirming the diagnosis. To date we have not diagnosed the disease in sheep in this State. The outbreaks are confined to the mountains or to those sections in which the land is wild, broken in contour, wooded, and covered with rank vegetation. Seldom has it occurred in the southeastern part of the state where the land is flat, rolling, and farmed extensively, except in steers (feeders) intended for fattening for the spring markets and introduced on farms in the fall after passage through various stockyards. Our records show that animals of all ages may be affected, cases having been reported during the year 1917 in which calves, heifers, and aged cows up to and including twelve years of age have been affected.

SYMPTOMS.

The period of incubation in natural infections appears in the majority of cases to be from twelve to seventy-two hours, but it is variable, and, except in the chronic cases, may run from six hours to eight days. At first there is a rapid rise in the body temperature to over 40°C. (104°F.) accompanied by a quickened pulse, dullness, rough coat, and muscular tremblings. In some cases the surface of the body feels alternately hot and cold, while the muzzle is dry. There is also cessation of appetite, rumination, and milk secretion. Peristalsis is often retarded; constipation at this stage may be noted. Later there are symptoms of colic with much straining at defecation and the passing of mushy to thin fecal matter with a fetid odor in which may be found fibrin, mucus flakes, and blood. Blood often exudes from the nose, and may sometimes be passed in the urine. Some animals show affections of the throat and are unable to swallow except with difficulty. Others show disinclination to move, exhibit stiffness, and in some instances actual lameness. Occasionally painful edematous swellings are seen about the legs and shoulders as well as in the throat. Animals have been observed to drop to the ground and die in a short time, apparently without pain. Others live for several hours in great pain, as indicated by groans and muscular spasms. Those sick for any length of time lose flesh quickly. In the edematous (exanthemous) form, the head and neck swell, especially in the region of the throat, and develop a deformity of these parts as a result of the rapidly increasing inflammatory edema of the subcutaneous connective tissue. In such cases swelling of the legs or inflammatory enlargements of the joints may be observed. The skin over the swollen parts of the body is tense, hot and sensitive. An acute conjunctivitis, with yellowish coloration of the conjunctiva, frequently develops with profuse lachrymation. The buccal mucous membrane is bright red, hot, dry, and swollen. Deglutition may be difficult or impossible, causing saliva to accumulate in the mouth and drivel from the corners in long tenacious strings. The tongue may swell to such an extent that it entirely fills the mouth cavity, or it may even protrude, appearing bluish red or dirty reddish brown in color.

Respiration is difficult, labored and heavy. Some animals die of asphyxiation, or asthenia, caused by a marked enteritis. The "sweating of blood," mentioned by Pearson, has been observed in a number of cases.

The pectoral form is characterized by an acute pleuro-pneumonia, and the animal stands with back arched, has a dry painful cough, and a colorless or reddish foamy discharge from the nose. One or both sides of the thorax may show a dullness (on percussion) over different

areas, with bronchial breathing and vesicular rales, or there may be a total absence of respiratory sounds. Respiration is greatly accelerated and labored. Rumination ceases, peristalsis of the rumen and intestines is frequently suppressed. Constipation is followed by bloody diarrhea, after which the weakened animal rapidly succumbs. The pectoral and abdominal forms of the disease are the ones seen in Pennsylvania, and we can recall no instance of having observed the edematous (exanthemous) form reported by some writers.

ANATOMICAL CHANGES.

The characteristic lesions of the disease are widely distributed areas of hemorrhage varying in size from a pin-point to several centimeters in diameter, in color from light red to almost black and frequently accompanied with a sero-fibrinous exudate, usually yellow but occasionally dark red in color. These serous hemorrhages, petechiae and ecchymoses, when extensive, give the entire abdominal or pectoral viscera the appearance of having been splashed with blood. All cases show some hemorrhagic areas in the subcutaneous connective tissue, the number and size of these varying in different individuals. Gas is not present in the subcutaneous connective tissue except as a post mortem change. The edematous cases show gelatinous infiltrations of the tissues. The abdominal and thoracic cavities may contain several quarts of yellow or reddish colored serous fluid.

Acute hemorrhagic inflammation of the intestinal tract is frequent—with thin fluid contents, gray in color or blood-stained, and having a very fetid odor. The blood is usually of a normal color and clots readily. The surface of the lungs is often petechiated or even ecchymotic. Pneumonia of the lobular type is very frequently found. On section this organ often presents areas of red and gray hepatization, having the marbled appearance seen in contagious pleuro-pneumonia, and when squeezed, exudes a yellow serum. The heart shows petechiae, ecchymoses, or more extensive hemorrhages of the pericardium or endocardium. The spleen is usually normal in appearance or at most may be swollen in localized areas presenting a few spleen tumors or petechiae. The liver in a small number of cases shows hemorrhagic infarcts, and is rich in blood. The kidneys are slightly if at all, affected, but sometimes show a few petechiae macroscopically.

Reynolds reports an outbreak in which meningitis was invariably present. Wilson and Brimhall report an animal four months pregnant which showed small hemorrhages in the placental membranes.

DIAGNOSIS.

Primarily this must depend upon the history and symptoms and can be verified by necropsy and bacteriological findings. Care should be taken not to mistake anthrax for hemorrhagic septicemia. A few of the most constant symptoms are repeated.

Animals show marked dullness and depression. They segregate themselves, stand with arched back, the coat is lusterless and staring. The feces are blood-stained and in some instances appear as almost pure blood. Some show bloody nasal discharge, others petechiae of nasal mucous membranes and conjunctiva. Temperatures run very high and "sweating of blood" is frequently observed. Edemas, particularly of the throat, are fairly constant.

Hemorrhagic septicemia may be differentiated from blackleg and malignant edema by the absence of gas in the subcutaneous tissue—from anthrax by the fact that on autopsy the spleen is not swollen and the blood is normal in appearance and clots readily. In anthrax the spleen is almost without exception uniformly swollen, the blood is dark and tarry and does not coagulate.

Decomposition changes, of a carcass dead for some time, alter the lesions and render diagnosis more difficult; therefore it is essential that carcasses should be examined shortly after death.

The pectoral form may readily be mistaken for pleuro-pneumonia; therefore in calves and shipped animals, care should be taken not to confuse it with this disease. The history should be of help in such cases.

CONTROL.

Because of the fact that the organism dies quickly under adverse conditions, traffic restrictions have not been rigid. Originally it was thought best to separate the sick from the well animals, removing them to other pastures, dividing them into small lots, and paying strict attention to the burning of carcasses, cleaning and disinfecting of stables, etc. Hutyra and Marek state that in India they aim to control the disease with the aid of protective vaccination, but give no data. Holmes found the simultaneous vaccination with serum (which he produced through the subcutaneous inoculation of cattle and buffaloes) and with virulent cultures most effective, though it is claimed that such vaccination is not without danger for the animals. It is

stated that the employment of cultures killed by heat, and also sterilized plueritic exudate, has given good results. Baldrey employed a vaccine prepared with cultures sensitized to immune serum and subsequently killed at 60°C., reducing his losses from 100% among non-vaccinated cattle to 22 to 28% in the vaccinated animals.

In 1912 Mohler and Eichhorn reported on some work done in immunizing the buffalos held in Yellowstone Park the previous year, and had no losses during the following twelve months. At this time they demonstrated by means of the complement fixation test that vaccinated animals respond with the production of immune bodies, and reactions were noted even three months following the vaccinations.

Having experienced unsatisfactory results with the isolation methods and internal medication recommended the Board decided to do a small amount of experimental work with vaccines. The method employed in the production of this vaccine and the reasons for its use in preference to other preparations have been treated of in two previous publications.

During the year 1915, the Board prepared and sent out vaccine which was used on 434 animals in eight different herds. Three hundred and thirty-six (336) head, including sick and healthy animals, in six herds were vaccinated. As a result of outbreaks in these herds 42 deaths had occurred prior to vaccination and six were sick when vaccinated. Three of the sick, and two apparently healthy animals in one herd died within one week. In other words in 1915 the disease was immediately checked in five of the infected herds, and there were no deaths in any of the herds after one week from the date of vaccination. In addition to this 166 other animals were vaccinated, on pastures adjoining those showing infection, with no losses.

In 1916, following the good results of the 1915 work, vaccine was used on 366 animals in seventeen infected native herds. Fifty-three deaths had occurred prior to vaccination. Nineteen showed clinical symptoms of the disease but were vaccinated along with the 347 head which were apparently unaffected. Ten of the sick cattle and four of the apparently healthy died within one week following vaccination. Additional deaths of seven head among those which had shown no clinical symptoms occurred at varying periods subsequent to the elapse of one week following vaccination. These losses were confined to six herds. In summarizing we find that during the year the disease was immediately checked in eleven of the seventeen herds, and that fifteen of the seventeen herds showed no losses subsequent to one week after vaccination. In addition, eighty-eight exposed animals on farms adjoining those having outbreaks were vaccinated prophylactically with no losses. The above figures for 1916 refer to outbreaks in native herds on pasture. Two hundred and fifty-eight cattle, in various herds, which had been exposed to shipped steers affected with

the disease commonly known as "shipping" or "stockyard pneumonia," were vaccinated prophylactically. There were twenty-three sick steers, distributed in eleven herds, of which twenty-two recovered following vaccination. None of the prophylactically treated cattle developed the disease.

Continuing in 1917, 895 animals were vaccinated in 38 herds on farms where the record showed 109 deaths prior to the receipt of the reports and administration of the vaccine. At the time of vaccination 18 animals were sick. Nine of these and eleven apparently healthy animals died following the vaccination. Eleven of those twenty deaths, including the nine sick, occurred within one week. In twenty-five of the thirty-eight infected herds the disease was immediately checked without further loss, and in thirty-four of the thirty-eight herds no loss was reported after one week from the date of vaccination. In other words there were but nine deaths from a total of 895 animals after one week following the vaccination and these deaths included all cattle reported by the owners as having died between the time of vaccination and the rendering of the reports which were received from six weeks to four months later. One hundred and sixty-three (163) animals, on which the vaccine was used as a prophylactic, did not develop the disease.

SUMMARY.

	Total herds.	Total animals in herds.	Deaths prior to vaccination.	Sick prior to vaccination.	Healthy vaccinated.	Sick vaccinated.	Deaths of sick following vaccination.	Deaths of healthy following vaccination.	Deaths after one week following vaccination.	Herds showing no deaths following vaccination.	Herds O. K. one week after vaccination.
1915, -----	6	403	42	3	360	6	3	2	0	5	6
1916, -----	17	419	53	19	347	19	10	11	7	11	15
1917, -----	38	1,004	109	18	877	18	9	11	9	25	34
Total, -----	61	1,831	204	43	1,584	43	22	24	13	41	55
Percentage, -----			11.1	2.3+			51+	1.5+	1.0	67+	90—

Mortality prior to vaccination (including sick which died), ----- 12.3+
 Mortality following vaccination (including deaths within week), ----- 1.5+
 Mortality following completion of vaccination (1 week), ----- 1%

In summarizing the work of vaccination for the control of hemorrhagic septicemia in cattle during the three years 1915 to 1917 inclusive, we find a total of sixty-one infected herds, containing 1,831 animals, showing 204 deaths, or 11.1%, prior to vaccination. Fifteen hundred and eighty-four (1584) healthy animals and forty-six (46) sick animals received vaccine. Twenty-two of the sick animals, or

51.1%, died. Twenty-four apparently healthy animals among the 1584 vaccinated, or 1.5%, died following the vaccination, eight of these within one week. Approximately one per cent. (1%) of losses only was recorded in treated stock, and, as previously mentioned, this includes all deaths, some of which were no doubt due to other causes. In forty-one of the total sixty-one herds the disease was immediately checked without further losses, and in forty-five of these sixty-one herds no deaths occurred after the lapse of one week from the date of vaccination. The mortality prior to vaccination was 12.3%. The mortality following vaccination, including deaths within one week, was 1.5%. The mortality following what we term the completion of the vaccination at the end of one week has been less than 1%.

A period of about one week following vaccination should be allowed for the development of immunity, during which time the vaccinated animals may still be susceptible to infection.

Furthermore, there has been but one reported case of hemorrhagic septicemia in the twenty-three (23) vaccinated herds of 1915 and 1916. This herd was vaccinated in 1916, and showed a recurrence in August, 1917. Of the four unvaccinated control herds from 1915, two have shown reappearance of the disease. Other strong evidence in favor of the vaccine may be added from the prophylactic vaccination of several hundred animals on pastures adjoining those on which the disease existed. The disease has not appeared among these exposed cattle.

We have frequently heard the remark that even though not vaccinated the remaining animals in infected herds might have shown no further losses. This may have been true of a few herds but is it reasonable to assume that the results recorded above would have been obtained without the aid of the vaccine.

